

addition, aluminum, copper, and other metal forms of these screens have relatively high thermal conductivities and also enhance heat transfer.

[0081] Another use for the capture structure (372, 372a, 372b, 372n-2, 372n-1, 372n) may be to enhance heat transfer. If the capture structure has a high thermal conductivity, it can act as an extended surface for heat transfer. By being in thermal contact with heat exchange channels 350, the capture structure (372, 372a, 372b, 372n-2, 372n-1, 372n) may promote heat transfer between the heat exchange channel and the liquid and vapor phases in the process microchannel 310.

[0082] The liquid channels (330, 415, 520, 530, 620, 720) may comprise microchannels although they may have larger dimensions that would not characterize them as microchannels. Each of these channels may have a cross section that has any configuration, for example, square, rectangular, circular, oval, trapezoidal, etc. Each channel may have an internal dimension of height or width in the range up to about 10 mm, and in one embodiment about 0.05 to about 10 mm, and in one embodiment about 0.05 to about 5 mm, and in one embodiment from about 0.05 to about 2 mm, and in one embodiment from about 0.5 to about 1 mm. The other internal dimension may be in the range from about 1 mm to about 100 mm, and in one embodiment about 5 mm to about 50 mm, and in one embodiment about 10 mm to about 20 mm. The length of the liquid channels may be in the range from about 1 cm to about 200 cm, and in one embodiment about 1 cm to about 50 cm, and in one embodiment about 2 to about 10 cm. The separation between each process microchannel 310 and the next adjacent liquid channel 330 may be in the range from about 0.05 mm to about 5 mm, and in one embodiment about 0.2 mm to about 2 mm.

[0083] The wicking region (332, 416, 525, 535, 625, 725) may comprise a wick and/or a wicking surface. The wicking region may preferentially retain a wetting fluid by capillary forces. The wicking region may comprise multiple continuous channels or grooves through which liquids may travel by capillary flow. The channels or grooves may be regularly or irregularly shaped. Liquid may migrate through a dry wick, while liquid in a liquid-containing wick can be transported by gravitational force or by applying a pressure differential, to the wick. The capillary pore size in the wicking material may be selected based on the contact angle of the liquid, the intended pressure gradient within the liquid channel and the surface tension of the liquid.

[0084] The wick in the wicking region (332, 516, 525, 535, 625, 725) may be made of different materials depending on the liquid that is intended to be transported through the wicking region. The wicking material may be a uniform material, a mixture of materials, a composite material, or a gradient material. For example, the wicking material may be graded by pore size or wettability to help drain liquid in a desired direction. Examples of wicking materials that may be used include: sintered metals, metal screens, metal foams, polymer fibers including cellulosic fibers, as well as other wetting porous materials. The capillary pore sizes in the wicking materials may be in the range of about 10 nm to about 1 mm, and in one embodiment about 100 nm to about 0.1 mm, where these sizes are the largest pore diameters in the cross-section of the wicking material observed by scanning electron microscopy (SEM).

[0085] The wicking region (332, 416, 525, 535, 625, 725) may comprise a wicking surface formed on one or more interior walls of the liquid channels. The wicking surface may comprise one or a plurality of grooves formed in one or more interior walls of the liquid channels. The grooves may be formed in the wall separating the liquid channel and the next adjacent process microchannel and/or heat exchange channel. The grooves may be used to assist with liquid capture and/or enhance heat transfer. The grooves may be straight or have tortuous configurations. The grooves may have serpentine configurations. The grooves may be tapered. The grooves may be hemispherical. The grooves may be formed using any suitable technique including etching, sawing, electrodischarge machining, etc. The grooves may be of any length. The grooves may have a depth of about 1 to about 1000 microns, and in one embodiment about 10 to about 500 microns. The grooves may have a width of about 1 to about 1000 microns, and in one embodiment about 10 to about 100 microns. The number of grooves in the wicking region may be in the range from 1 to about 1000 grooves per centimeter as measured across the widths of the grooves, and in one embodiment from 1 to about 100 grooves per centimeter. In one embodiment, the grooves may have a constant or decreasing width from the top to the bottom of the grooves. In one embodiment, the grooves may form a mouth to larger diameter pores for liquid transport. Liquid may migrate through the grooves as a result of capillary flow. The flow of liquid in the grooves may be parallel (co-current or counter-current) or tangential (cross-current) to the flow of vapor in the adjacent process microchannels. The grooves may be oriented to direct the flow of liquid within the liquid channels and/or direct the flow of liquid between microchannel distillation sections. The grooves may be used to manifold the liquid from one microchannel distillation section to another microchannel distillation section. The microchannel distillation sections may be connected through the grooves in parallel or series, upstream or downstream from one another.

[0086] In one embodiment, the wicking region (332, 416, 525, 535, 625, 725) may comprise a wick positioned within the liquid channels and a wicking surface (e.g., grooves) formed in one or more of the interior walls of such liquid channels.

[0087] In operation, the wicking region (332, 416, 525, 535, 625, 725) may be filled with liquid. When wet or saturated, the wick transports liquid through porous flow passages to a lower pressure zone, such as a lower pressure created by suction.

[0088] Punctured and punctured/expanded foils may be used as the wicking material in the wicking region (332, 416, 525, 535, 625, 725) and/or as the capture structures (372, 372a, 372b, 372n-2, 372n-1, 372n). Useful foils include Ultra Thin MicroGrid Precision-Expanded Foils, available from Delker Corporation. These materials are made in a flattened form and a three-dimensional expanded form. Although similar to conventional wire mesh screens, these materials are made from a single thin sheet by punching an array of holes while pulling the material. In the flattened form the holes are an array of diamonds. In the expanded form, the filaments are in a regular tetrahedral configuration. These materials can be made in thicknesses as small as about 0.0015 inch (1.5 mil) and from a variety of metals, including copper, aluminum and nickel.